WRINKLE RIDGES. RIFTS AND THE TECTONIC HISTORY OF VENUS. F. Bilotti[1] and J. Suppe, Department of Geosciences, Guyot Hall Princeton, NJ 08544. [1]now at Texaco EPTD, 3901 Briarpark, Houston, TX 77042.

New digital mapping of over 65,000 wrinkle ridges of the plains of Venus shows a strong correlation between the location and orientation of these long, low-amplitude compressive anticlines and major features of the geoid and long-wavelength topography. Regions of wrinkle ridges occupy 43% of the plains and are strongly skewed toward low elevations and negative geoid height. Figure 1a shows that about 93% of the plains deformed by wrinkle ridges lie below mean planetary radius and 72% have negative geoid height. In contrast, the rifts of Venus are strongly skewed toward high elevations and positive geoid anomalies (Fig.†1b). Thus compressive deformation dominates the topographic and geoid lows, whereas rifting is generally restricted to the highs.

The orientations of wrinkle ridges are consistent over regions extending for 1000–10,000 km. Many regions display multiple sets of wrinkle ridges of different orientations reflecting multiple episodes and directions of compression, however about 80% of the regions display a single dominant wrinkle ridge orientation, with secondary orientations subordinate. The dominant wrinkle ridge orientations follow the contours of long-wavelength topography and geoid or lie along the axes of troughs in the geoid. Thus the maximum horizontal compression recorded by the folds is commonly parallel to the present-day gradient in geoid and topography, although some regions are strong exceptions, perhaps reflecting changes in topography and geoid with time.

The dominant wrinkle-ridge trends ring several major geoid and topographic swells, principally Western Aphrodite Terra (Fig. 2), Themis Regio and Lada Terra, with ring diameters of 90–120°. In addition there are smaller rings of wrinkle ridges around the swells in Eistla and Bell Regiones (approximately 30°), especially Gula Mons. In contrast there are no rings of compressive deformation surrounding other geoid/topographic highs, including Beta and Atla Regio, which have been proposed to be the youngest swells and display the largest peak geoid/topography ratios and largest geoid gradients. These observations are consistent with the idea that not all the major topographic/geoid swells existed on Venus at the time of wrinkle ridge formation.

Many of the large-scale properties of wrinkle ridge and rift distribution are consistent with the swell-push model for lithospheric stress [3]. Stresses resulting from the swell-push body force due to either isostatic or dynamic compensation result in a stress field that is directly related to the geoid height — areas of positive geoid in overall extension and areas of negative geoid in compression [3]. Comparison between the above mapped tectonic features and the predicted stress field of the swell-push model suggests that the geometries of most rift zones and several large-scale wrinkle ridge systems are consistent with the present-day stress field. The details of agreement and disagreement between the observed tectonics and the model help us determine relative ages for geoid/topographic highs. The first-order distribution of rift zones and wrinkle ridges agrees with the swell-push model — rift zones are found in areas of positive geoid and high elevation while plains thrust faults (wrinkle ridges) occur in regions of low elevation and negative geoid. This correlation between tectonic features and the predicted present-day stress indicates that rifts and wrinkle ridges formed in a stress-field similar to the present one. Regions of disagreement between the model and the observed tectonic features are regions where the stress field has changed since the deformation, or the model is wrong.

Several large-scale wrinkle ridge systems that are consistent with the predicted present-day stress field have parts that are not consistent with this stress field. For example, Fig. 2 shows the wrinkle ridge ring around the Western Aphrodite Terra geoid high. The unshaded rose plots to the southeast of Aphrodite indicate disagreement with the predicted stress for about 30% of the ring. The paleo-stress field which formed the ring was perturbed by the formation of the younger Atla Regio geoid high. No wrinkle ridges have formed around Atla suggesting a lower stress magnitude or a strengthening of the Venusian lithosphere with time. Other uplifts also seem to be younger than the wrinkle ridge deformation, Beta and Eistla Regiones are examples. Although many wrinkle ridges are consistent with the present-day stress field, it is not clear if any wrinkle ridges are forming today.

References: [1] Bilotti, F., Venus Wrinkle Ridges: Structure, distribution, and implications for global tectonic evolution, Ph.D. thesis, Princeton University, Princeton, 1997. [2] Ford, P.G., and G.H. Pettengill, Venus topography and kilometer-scale slopes, *J. Geophys. Res.*, *97*, 13,103–13,114, 1992. [3] Sandwell, D.T., C.L. Johnson, F. Bilotti, and J. Suppe, Driving forces for limited tectonics on Venus, *Icarus*, *in press*, 1996.

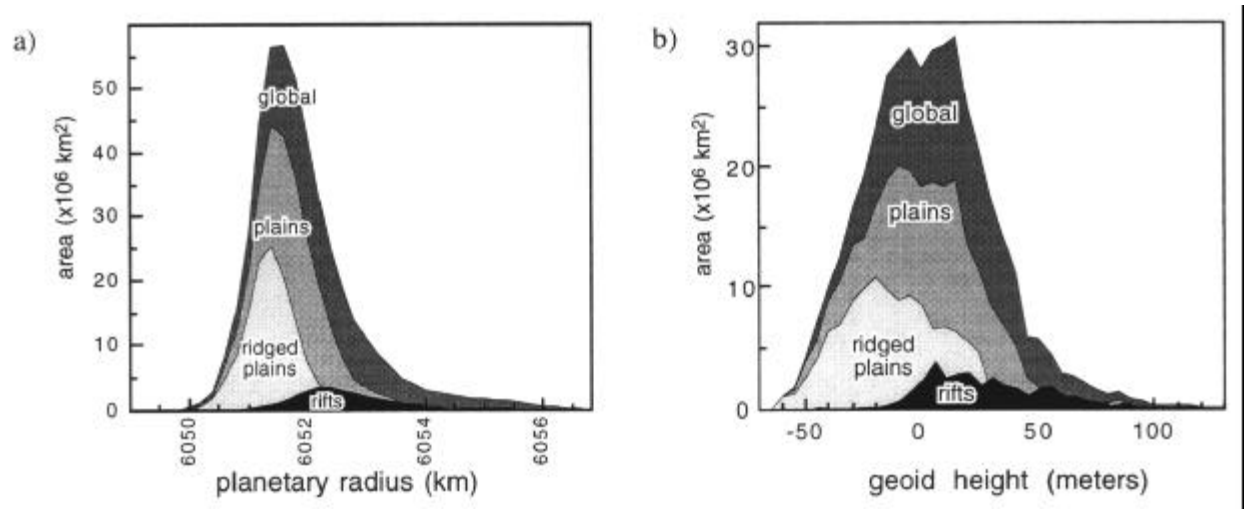

Fig. 1. Hypsometry and geoid distribution of ridged plains, plains and rifts, compared to the global distribution. **(a)** Global, plains, ridged plains, and rifts hypsometric curves from the global topography [2]. The elevation is plotted against the amount of area within 200-m elevation bins. Notice that the wrinkle ridge hypsometry is skewed toward low elevation with respect to the global mean radius as well as the mean plains elevation. **(b)** Geoid distribution plotted similarly to **(a)**. Again, the wrinkle ridge distribution is skewed with respect to both the global and plains distributions.

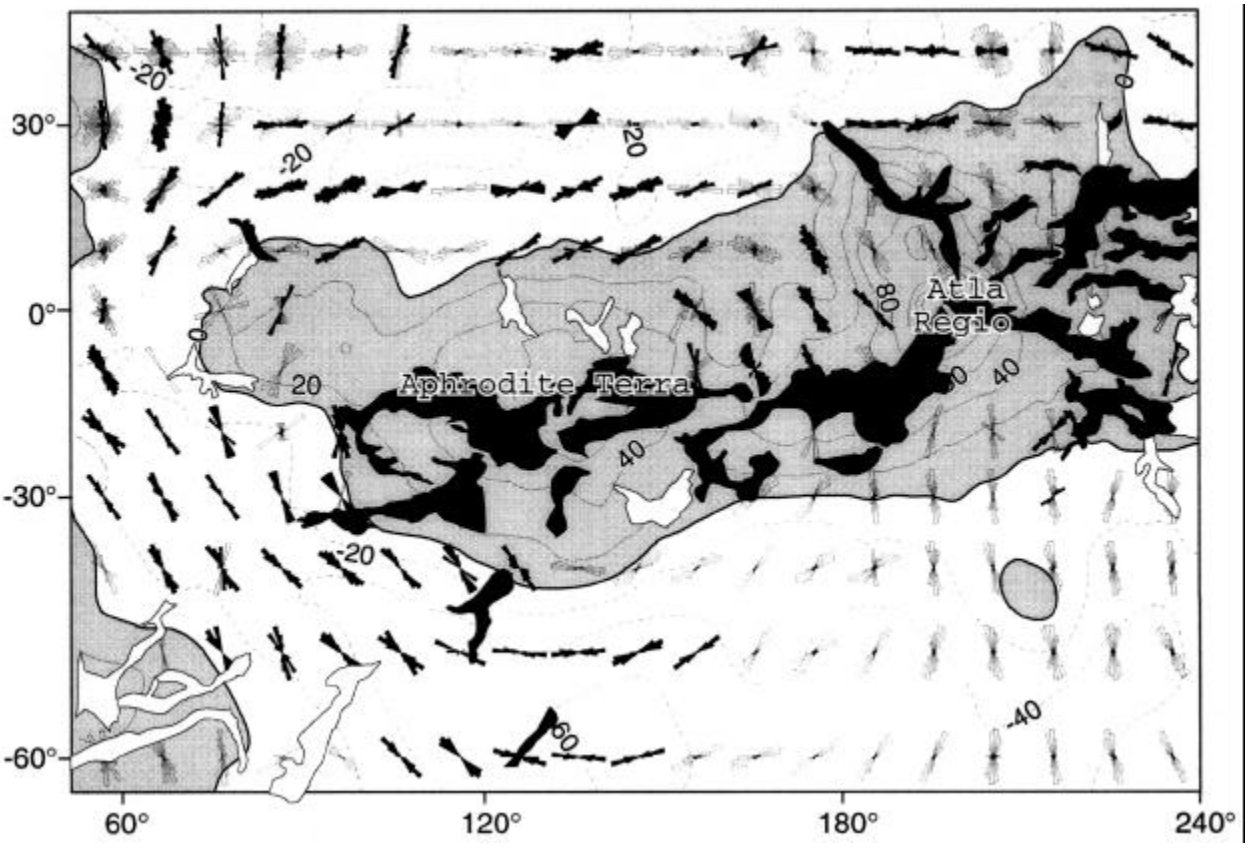

Fig. 2. Results of comparison between wrinkle ridge and rift orientations and predicted present-day stress from the swell-push model [3]. The normalized rose plots are derived from the global wrinkle ridge map by Bilotti and Suppe (1996). Black wrinkle ridge rose plots and rift zones have orientations within 15° of that predicted by the well-push model while white rift zones and wrinkle ridge rose plots do not. The contours are geoid height in meters, with positive geoid regions shaded gray.